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PHYTOTOXICOLOGY ASSESSMENT SURVEYS IN THE VICINITY OF C-I-L AND DOMTAR, CORNWALL - 1984, 1985, 1986

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Phytotoxicology Section
Air Resources Branch

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Executive Summary

The Phytotoxicology Section has conducted surveys of mercury contamination of soil and/or vegetation in the vicinity of C-I-L Inc., Cornwall, annually since 1976. In 1985, the Phytotoxicology Section combined the above study with a survey of vegetation contamination and injury due to chlorine emissions from Domtar Ltd., located immediately south of C-I-L. The results of C-I-L/Domtar surveys undertaken in 1984, 1985 and 1986 are presented in this report.

Results of tree foliage, moss bag and soil surveys conducted in Cornwall during 1984-1986 revealed a pattern of decreasing mercury concentrations with increasing distance from C-I-L. Average mercury levels in tree foliage increased slightly from 1983 through 1986 but remained lower than results for most prior years.

Mercury concentrations in samples of surface soil collected in the vicinity of C-I-L did not change appreciably from 1976 to 1985.

Analysis of tree foliage samples collected in Cornwall in 1985 and 1986 revealed that the highest chlorine levels were present at the stations nearest Domtar. Chlorine injury to vegetation has been documented on residential properties downwind of Domtar, with a noticeable deterioration in vigour of several trees in this area having occurred in recent years.

Sommaire

Depuis 1976, la section de phytotoxicologie effectue chaque année des études près de l'usine CIL de Cornwall, sur la contamination du sol et de la végétation par le mercure. En 1985, la section a combiné les résultats de ces études avec ceux d'une étude sur la contamination et l'endommagement de la végétation dus aux émissions de chlore provenant de l'usine Domtar, située juste au sud de l'usine CIL. On présente dans le présent raport les résultats des études CIL/Domtar effectuées en 1984, 1985 et 1986.

Les résultats des études effectuées sur le feuillage des arbres et sur le sol, ainsi que par filtrage à la mousse végétale, entre 1984 et 1985 à Cornwall, indiquent que les concentrations de mercure diminuent à mesure qu'on s'éloigne de l'usine CIL. Les concentrations moyennes de mercure sur le feuillage des arbres présentent une faible augmentation de 1983 à 1986, mais demeurent néanmoins inférieures aux résultats de la plupart des années précédentes.

Il n'y a pas eu de changements notables dans les concentrations de mercure des échantillons de sol prélevés dans les environs de l'usine CIL de 1976 à 1985.

L'analyse des échantillons de feuillage d'arbres prélevés à Cornwall en 1985 et 1986 révèlent que les concentrations de chlore les plus élevées se trouvent près de l'usine Domtar. L'endommagement de la végétation dû au chlore a fait l'objet de recherches sur les propriétés privées sous le vent par rapport à l'usine Domtar, et on a constaté qu'au cours des dernières années, il y a eu une détérioration appréciable de la vitalité de plusieurs arbres dans cette région.

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1.0 INTRODUCTION

The Phytotoxicology Section has conducted surveys of mercury (Hg) contamination of vegetation and/or soil in the vicinity of the C-I-L Inc. chlor-alkali plant in Cornwall annually since 1976. A report presenting the results of surveys conducted in 1982 and 1983 was released in May 1985 (Rinne, 1985a).

In 1985, subsequent to receipt of complaints from nearby residents, the Phytotoxicology Section initiated surveys of chlorine contamination and injury to vegetation in the vicinity of Domtar Ltd., which is located due south of C-I-L.

This report presents the results of Phytotoxicology surveys conducted in the vicinity of C-I-L and Domtar in 1984, 1985 and 1986.

2.0 METHODS

In mid-August of 1984, 1985 and 1986, duplicate samples of maple foliage were collected from 22 stations in the vicinity of C-I-L and Domtar (Fig. 1) and from control locations in Ingleside, west of Cornwall. During the 1985 survey, duplicate surface soil samples (0- 5 cm in depth) also were collected at each station.

Moss bag monitoring was conducted in all three years. Bags were exchanged monthly for various portions of the year at six stations downwind of C-I-L and an upwind control station (Fig. 2), and at five locations on the roof of the C-I-L mercury cell room (Fig. 3).

All samples were processed in the Phytotoxicology laboratory prior to submission to the MOE Resources Road laboratory for analysis of

mercury. Additionally, tree foliage samples collected in 1985 and 1986 were analyzed for chlorine.

3.0 RESULTS

3.1 Mercury (C-I-L Emissions)

3.1.1 Mercury in Tree Foliage

Mercury concentrations in unwashed tree foliage collected in the vicinity of C-I-L/Domtar in August of 1984, 1985 and 1986 are given in Table 1, and are compared with prior years' levels. Average mercury levels in foliage increased slightly from 1983 through 1986, but 1986 levels remained lower than average 1982 and most prior years' concentrations. Mercury concentrations in the 1986 foliage samples are depicted in Fig. 4. The zone of "above normal" levels (>0.3 µg/g Hg) extends approximately 1300 m downwind of the cell room.

Total annual and growing season (May - August) cell room Hg emissions to atmosphere reported to the MOE by C-I-L are shown in Table 2. Fig. 5 compares the reported cell room growing season Hg emissions with average Hg concentrations in maple foliage. There is a reasonable correlation, with the exception of 1982, when foliar mercury levels were very high. As discussed in a previous report (Rinne, 1985a), the high 1982 levels were attributed to frequent operation of the C-I-L Hg retort (separate from the cell room).

3.1.2 Mercury in Moss Bags

Tables 3, 4 and 5 give the results of moss bag monitoring conducted in 1984, 1985 and 1986, respectively. Monthly moss bag exchanges were conducted by Cornwall MOE (Cornwall stations) and by C-I-L personnel (Hg cell room

roof). The results for the seven Cornwall stations corroborate the tree foliage results, with Hg concentrations decreasing with increasing distance from the C-I-L Hg cell room. Of particular note is the high mercury concentration (60 µg/g) for November 1986 at moss bag Sta. 108, along Brookdale Avenue north of the cell room. This is the highest off-property Hg concentration ever detected in any environmental medium during Phytotoxicology monitoring in Cornwall. The 1986 moss bag results are further illustrated in Fig. 6.

The Hg cell room roof moss bag results (Tables 3, 4, 5) show some interesting seasonal variations, in that moss bag mercury concentrations increased during the winter months, although cell room emissions (as given in C-I-L monthly reports to MOE) decreased. This resulted in higher ratios of mean moss bag Hg concentrations: reported Kg emissions in the winter months than the summer months, indicating that in most cases moss bags are more efficient accumulators of Hg in winter than in summer. In order to further explore the reasons for this seasonal variation, climate statistics for Cornwall for the years 1984, 1985 and 1986 were assembled (see Appendices 1, 2 and 3). Correlations were then calculated between the ratio of mean mercury concentration : Kg emissions (both absolute ratios and their natural logarithms) and both total monthly precipitation and mean monthly temperature. The best overall relationship ($r = -0.65$, $p < 0.001$) for combined 1984, 1985 and 1986 data was that between the natural logarithm of the cell room moss bag Hg concentration ratio and mean monthly temperature. The r value was as large as -0.87 ($p < 0.001$) for individual year's (1985) data. The increased ability of moss bags to retain Hg in cooler weather is almost certainly related to the relatively high volatility of this pollutant.

The moss bag concentration ratios for November and December of 1985 (Table 4) are very high compared to the same two months of 1984 and 1986 (Tables 3 and 5, respectively). There is an apparent discrepancy between high measured moss bag concentrations and low reported cell room emissions for these two months of 1985. Weather differences do not explain this discrepancy, and the cause is unknown at present.

3.1.3 Mercury in Soil

The Hg concentrations in surface soil (0 - 5 cm) samples collected in 1985 are shown in Table 6, and are compared with earlier years' (1976, 1978) results. There appears to have been very little overall change in soil mercury concentrations in Cornwall during this period. Again, a relationship with proximity to the C-I-L cell room is apparent. This relationship is further illustrated in Fig. 7.

3.1.4 Mercury in Air

The Air Quality and Meteorology Section of the Air Resources Branch conducted an air monitoring survey in Cornwall in September 1986 (Chapman, 1987). A mobile air monitoring unit (MAMU) measured mercury in ambient air at several locations. Although concentrations were related to distance from C-I-L, there were no exceedances of the health-based air quality standard of 5.0 µg Hg/m^3 (½ h avg.). The maximum ½ h avg. concentration measured was 1.32 µg/m^3 in the C-I-L parking lot 60 m NE of the cell room.

Reference to Table 5 of the present report reveals that the moss bag monitoring results for September 1986 were relatively low for both C-I-L cell room and downwind moss bags. It is possible that had the MAMU survey been conducted in October or especially November, exceedances of the 5.0 µg/m^3 standard may well have been measured.

3.2 Chlorine (Domtar Emissions)

3.2.1 Chlorine in Tree Foliage

Chlorine concentrations in unwashed maple foliage collected in Cornwall in 1985 and 1986 are given in Table 7. Potential sources of the element chlorine in tree foliage include root uptake and/or spray drift of salt (NaCl, $CaCl_2$) from road salting operations and exposure to industrial air pollutants such as Cl_2, ClO_2, HCl, etc. Chlorine in tree foliage is analyzed as the chloride (Cl^-) ion. Due to natural variations in chlorine concentrations of foliage among different species, and to wide variations in exposure resulting from road salt de-icing applications, the Phytotoxicology Section has not established an "upper limit of normal" guideline for chlorine in tree foliage. Nevertheless, the data in Table 7 do reveal an association of elevated foliar chlorine levels with proximity to Domtar. In 1986, the three nearest sampling stations to Domtar (all within 540 m, and with no intervening structures) had the three highest chlorine concentrations (all ≥0.80 µg/g). This is further illustrated in Figure 8.

3.2.2 Chlorine Injury to Vegetation

In recent years, the Phytotoxicology Section has investigated several complaints of vegetation injury downwind (east) of Domtar. The reports of these investigations (Rinne, 1984, 1985b, 1986) have concluded that the primary cause of injury to garden vegetables, ornamental flowers and shrubs, and trees was chlorine (Cl_2) emissions from the Domtar operations.

During the 1986 survey, chlorine injury to vegetation also was observed on municipal property immediately north of

Domtar. Although C-I-L is a potential chlorine source, the injury pattern clearly implicated Domtar (Rinne 1985b, 1986).

Salt toxicity can cause marginal burn of foliage similar to that which has been observed downwind of Domtar and attributed to chronic chlorine fumigation (the actual toxic agent, the chloride ion, is the same in both cases). Salt spray from Brookdale Avenue and/or the initial section of the Seaway Bridge was ruled out as a significant factor because such injury would be predominant in the spring of the year (on deciduous species) and because vegetation injury has not been observed on residential properties north of Fourth Street and south of Second Street (i.e. outside of the "zone of influence" of Domtar) (Rinne, 1986).

On the basis of these findings as well as personal observations during the past few years of the decline of several trees in the residential area east of Brookdale Avenue, it is clearly apparent that releases of chlorine from Domtar have and are continuing to impair the health of vegetation in the vicinity (primarily downwind) of the mill. This effect can be confirmed by observations from the east side of Brookdale Avenue at Third Street towards the north and south. This area is characterized by a virtual absence of trees. It is apparent, therefore, that unless corrective action is taken, the situation will continue to deteriorate.

3.2.3 Chlorine in Air

A survey conducted in September 1986 by the Air Quality and Meteorology Section of the Air Resources Branch (DeBrou, 1987) measured chlorine (Cl_2) and chlorine dioxide (ClO_2) concentrations in ambient air over a

three-week period at several locations near Domtar and C-I-L. The survey results showed that C-I-L was not a source of either Cl_2 or ClO_2 during the monitoring period. However, both Cl_2 and ClO_2 were measured downwind of Domtar. ClO_2 concentrations were well below the health-based standard of 85 $\mu g/m^3$ ($\frac{1}{2}$ h avg.), but Cl_2 concentrations exceeded the health and vegetation based standard of 300 $\mu g/m^3$ ($\frac{1}{2}$ h avg.) in 10 of the 37 sampling periods. The maximum $\frac{1}{2}$ h avg. concentration of Cl_2 was 840 $\mu g/m^3$, nearly three times higher than the standard.

4.0 SUMMARY

4.1 C-I-L Emissions Effects

Results of tree foliage, moss bag and soil surveys conducted in 1984, 1985 and/or 1986 in the vicinity of C-I-L, Cornwall, all revealed a pattern of decreasing mercury concentrations with increasing distance from C-I-L.

Average mercury levels in tree foliage increased slightly from 1983 through 1986, but remained relatively low compared to most prior years' survey results. However, the highest Hg level ever measured in Phytotoxicology monitoring off of the C-I-L property was present in a moss bag exposed during November 1986 along Brookdale Avenue, due north of the cell room.

Mercury concentrations in surface soil samples in Cornwall did not change appreciably from 1976 to 1985.

4.2 Domtar Emission Effects

Results of tree foliage surveys conducted in 1985 and 1986 in the vicinity of Domtar/C-I-L revealed that the highest chlorine levels were present at the stations closest to Domtar.

Chlorine injury to vegetation on residential properties downwind of Domtar has been thoroughly documented in Phytotoxicology complaint investigations. During the annual 1986 surveillance, foliar injury also was observed on municipal property immediately north of Domtar. A noticeable deterioration in vigour of several trees downwind of Domtar has occurred in recent years, and this trend is likely to continue unless emissions from Domtar are reduced.

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Table 1 – Mercury Concentrations in Unwashed Tree Foliage Collected in Cornwall, 1976-1986

Station No. (see Fig. 1)	Distance (m) and Direction from C-I-L Hg Cell Room	Maple Species (1986)	Mercury (ug/g, dry weight) 1976	1977	1978	1979	1980	1981	1982	1983	1976-83 Mean	1984	1985	1986
1	360 N	Silver	6.3	4.1	0.61	1.3	2.0	1.6	16.0	1.2	4.1	1.1	1.3	0.84
2	360 NNE	Manitoba	15.0	18.0	2.0	2.7	4.9	3.7	23.0	1.7	8.9	1.9	3.7	2.9
4	240 E	Manitoba	2.7	3.5	5.3	2.9	14.0	7.3	9.8	3.0	6.1	3.4	3.8	6.8
6	400 ENE	Sugar	1.6	7.2	3.4	2.0	4.2	2.3	4.2	2.3	3.4	2.7	1.9	3.2
8	560 E	Red	0.6	1.3	1.0	0.59	1.2	0.56	0.64	0.44	0.79	0.49	0.37	0.66
9	600 ENE	Silver	1.3	3.8	1.5	1.1	2.0	0.92	1.7	0.94	1.7	1.0	0.77	1.2
10	750 NNE	Silver	1.2	1.1	0.32	0.45	0.65	0.29	0.37	0.35	0.59	0.32	0.53	0.34
11	1120 NE	Manitoba	1.3	0.88	0.45	0.69	0.74	0.31	0.81	0.34	0.69	0.42	0.52	0.42
12	680 NW	Silver	0.18	0.18	0.07	0.18	0.20	0.06	0.08	0.03	0.12	0.05	0.03	0.10
14	240 SW	Norway	1.5	1.1	0.74	1.6	1.0	0.69	1.2	0.62	1.1	0.94	0.93	2.2
16	760 ESE	Manitoba	0.42	0.37	0.28	0.25	0.79	0.54	0.18	0.21	0.38	0.29	0.17	0.19
19	760 SW	Manitoba	-	-	0.15	0.18	0.69	0.20	0.64	0.44	0.38	0.16	0.25	0.48
21	720 SSE	Silver	0.13	0.45	0.33	0.28	0.39	0.40	0.23	0.36	0.32	0.46	0.17	0.20
22	1700 E	Silver	-	-	0.15	0.11	0.20	0.18	0.23	0.14	0.17	0.14	0.09	0.14
23	760 N	Silver	0.36	0.28	0.22	0.45	0.32	0.10	0.17	0.08	0.25	0.10	0.08	0.06
25	1440 NNE	Manitoba	0.71	0.31	0.22	0.37	0.28	0.26	0.57	0.18	0.36	0.22	0.36	0.14
27	840 E	Silver	0.45	0.72	0.57	0.40	0.55	0.51	0.54	0.31	0.51	0.31	0.25	0.38
32	1880 ENE	Silver	0.22	0.38	0.23	0.18	0.32	0.28	0.36	0.23	0.28	0.20	0.11	0.17
33	700 W	Norway	0.25	0.18	0.15	0.22	0.21	0.20	0.24	0.14	0.20	0.05	0.05	0.11
35	1740 WSW	Silver	0.09	0.09	0.04	0.23	0.16	0.10	0.09	0.10	0.11	0.07	0.06	0.08
36	2300 NE	Manitoba	-	0.26	0.18	0.15	0.19	0.22	0.09	0.13	0.17	0.24	0.20	0.18
37	3500 NE	Norway	-	0.20	0.12	0.11	0.18	0.14	0.10	0.11	0.14	0.12	0.11	0.11
Mean of all stations			1.9	2.2	0.82	0.75	1.6	0.95	2.8	0.61	1.5	0.67	0.72	0.95
Controls (collected a minimum distance of 20 kw W of Cornwall		Manitoba	-	0.07	0.04	0.06	0.04	0.12	0.05	0.04	0.06	0.04	0.03	0.04
		Silver	0.05	0.06	0.05	0.04	0.05	0.05	0.12	0.04	0.06	0.04	0.05	0.03
		Norway	-	-	-	-	-	-	-	-	-	0.03	0.05	0.01
Correlation coefficient (r) between Hg concentrations of foliage and distance from cell room in a NE direction (ln/ln transformed)			-0.82	-0.95	-0.93	-0.96	-0.95	-0.91	-0.90	-0.95	-0.96	-0.93	-0.95	-0.94

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Table 2 - C-I-L Cell Room Mercury Emissions to Atmosphere* - 1976 to 1986

Year	Total Annual Emissions (kg)	May-August Emissions (kg)	May-August Emissions as % of Total
1976	220.9	87.6	39.7%
1977	231.20	112.0	48.4%
1978	184.17	80.4	43.7%
1979	134.72	50.8	37.7%
1980	117.06	59.8	51.1%
1981	81.95	38.5	47.0%
1982	69.57	29.7	42.7%
1983	54.59	26.0	47.6%
1984	46.19	21.5	46.5%
1985	39.62	21.4	54.0%
1986	69.79	31.3	44.8%

*Sum of Hg emitted in building ventilation, strong hydrogen and end box ventilation (information provided by C-I-L, Cornwall).

Table 3 - Mercury in C-I-L, Cornwall Moss Bags Exposed Monthly During 1984

Station No. (Fig. 2)	Distance (m) and Direction from C-I-L Hg Cell Room	Hg Concentration (ug/g, dry weight)							
		May	June	July	August	September	October	November	December
108	320 N	7.1	1.6	2.4	1.8	2.1	0.66		
114	700 NE	0.43	0.13	0.45	0.34	0.51	0.25		
116	1080 NE	0.18	0.24	0.19	0.25	-	0.12		
125	2400 NE	0.17	0.25	0.37	0.17	0.71	0.12		
129	3100 NE	-	0.16	0.30	0.24	0.46	0.10		
128	5900 NE	0.11	0.27	0.25	0.17	1.3	0.21		
122	5500 NW	0.15	0.07	0.11	0.15	0.33	0.10		
Roof of Hg cell room: #1		990	1100	1500	1000	670	980	860	970
Roof of Hg cell room: #2		350	550	560	680	450	590	400	520
Roof of Hg cell room: #4		910	530	920	860	600	310	1000	800
Roof of Hg cell room: #5		450	400	930	530	360	230	520	800
Roof of Hg cell room: #7		140	210	590	190	170	160	310	610
Cell room - Mean		568	558	900	652	450	454	618	740
Cell room Hg emissions - Kg		3.53	4.71	6.46	6.80	4.36	4.76	5.39	2.06
Ratio*		161:1	118:1	139:1	96:1	103:1	95:1	115:1	359:1

*Mean cell room moss bag concentration : Reported cell room emissions.

Table 4 - Mercury in C-I-L, Cornwall Moss Bags Exposed Monthly During 1985

Station No. (Fig. 2)	Distance (m) and Direction from C-I-L Hg Cell Room	Hg Concentration (ug/g, dry weight)											
		January	February	March	April	May	June	July	August	September	October	November	December
108	320 N					2.7	10.0	3.0	0.30	5.0	16.0		
114	700 NE					0.84	2.7	0.70	0.26	0.87	1.1		
116	1080 NE					0.36	0.32	0.18	0.28	0.79	0.33		
125	2400 NE					0.48	0.71	0.22	1.0	0.60	0.43		
129	3100 NE					0.23	0.27	0.54	0.14	0.19	0.33		
128	5900 NE					0.46	0.35	0.11	0.15	0.15	2.1		
122	5500 NW					0.80	0.50	1.5	0.11	0.12	0.30		
Roof of Hg cell room: #1		1610	1120	1770	1200	1100	640	1500	720	620	860	1300	1500
Roof of Hg cell room: #2		1150	850	970	490	570	110	360	540	220	360	640	990
Roof of Hg cell room: #4		1230	1440	1300	1000	720	450	400	710	510	920	1200	1500
Roof of Hg cell room: #5		775	1110	1400	420	610	570	360	550	370	490	830	1020
Roof of Hg cell room: #7		430	750	620	980	470	170	290	370	230	350	700	670
Cell room - Mean		1039	1054	1212	818	694	388	582	548	390	596	934	1136
Cell room - Hg emissions - Kg		1.95	1.48	3.56	3.25	5.58	6.38	5.02	4.41	3.36	2.80	0.98	0.84
Ratio*		533:1	712:1	340:1	252:1	124:1	61:1	116:1	131:1	116:1	43:1	953:1	1352:1

*Mean cell room moss bag concentration : Reported cell room emissions.

Table 5 - Mercury in C-I-L, Cornwall Moss Bags Exposed Monthly During 1986

Station No. (Fig. 2)	Distance (m) and Direction from C-I-L Hg Cell Room	Hg Concentration (ug/g, dry weight)												May-Dec. Mean
		January	February	March	April	May	June	July	August	September	October	November	Dec.	
108	320 N					1.0	8.6	2.4	1.2	1.4	27	60	2.8	13.1
114	700 NE					0.36	0.76	0.34	0.40	0.53	5.0	6.4	1.4	1.9
116	1080 NE					0.34	0.35	0.38	0.32	0.36	0.64	-	0.58	0.42
125	2400 NE					0.27	0.36	0.36	0.31	0.32	0.93	1.5	1.4	0.68
129	3100 NE					0.26	0.34	0.30	0.32	0.36	1.5	1.4	0.52	0.62
128	5900 NE					0.26	0.30	0.20	0.28	0.21	1.3	-	0.33	0.41
122	5500 NW					0.21	0.17	0.25	0.20	0.23	0.48	1.0	-	0.36
Roof of Hg cell room: #1		1400	590	950	510	1200	1300	600	1400	410	240	140	730	
Roof of Hg cell room: #2		1200	410	900	400	300	380	240	300	200	110	290	740	
Roof of Hg cell room: #4		1300	450	1020	1300	1600	740	820	450	620	560	1300	1700	
Roof of Hg cell room: #5		860	460	950	460	510	540	480	220	280	180	470	770	
Roof of Hg cell room: #7		710	500	1010	440	600	720	280	240	550	320	660	610	
Cell room - Mean		1094	482	966	622	842	736	484	522	412	282	572	910	
Cell room - Hg emissions - Kg		1.98	1.42	3.56	7.26	6.80	6.14	7.23	11.11	8.14	8.61	4.07	3.48	
Ratio*		533:1	339:1	271:1	86:1	124:1	120:1	67:1	47:1	51:1	33:1	141:1	261:1	

*Mean cell room moss bag concentration : Reported cell room emissions.

Table 6 - Mercury Concentrations (ug/g, dry weight) in Surface Soil Collected in the Vicinity of C-I-L, Cornwall - 1976, 1978 and 1985

Station No.	Distance (m) and Direction from Hg Cell Room	1976 (0-5 cm)	1978 (0-5 cm)	1985 (0-5 cm)
1	360 N	2.1	2.2	2.6
2	360 NNE	2.1	4.3	3.3
4	240 E	2.6	4.2	3.7
6	100 ENE	0.93	1.3	0.43
8	560 E	0.26	0.27	0.48
9	600 ENE	0.56	0.60	0.97
10	750 NNE	0.28	0.31	0.51
11	1120 NE	0.27	0.30	0.26
12	680 NW	0.05	0.02	0.06
14	240 SW	0.40	0.61	0.79
16	760 ESE	0.14	0.20	0.34
19	760 SW	-	0.33	(1.4)
21	720 SSE	0.19	0.28	0.46
22	1700 E	-	0.14	0.26
23	760 N	0.07	0.14	0.12
25	1400 NNE	0.23	0.15	0.32
27	840 E	0.48	0.23	0.36
32	1880 ENE	0.15	0.13	0.20
33	700 W	0.08	(1.75)	0.15
35	1740 WSW	0.08	0.06	0.09
36	2300 NW	-	0.14	0.12
37	3500 NE	-	0.08	0.09
Mean soil Hg concentration		0.61	0.76	0.74
Mean concentration in rural control soil samples		-	-	0.07
% of stations exceeding current "upper normal" level (underlined)		28	29	29

Note: Phytotoxicology Section "upper limit of normal" Hg concentration in urban soil (0-5 cm depth) is 0.5 ug/g.

Table 7 - Chlorine Concentrations in Unwashed Tree Foliage Collected in Cornwall - 1985, 1986

Station No.	Distance (m) and Direction from Domtar	Maple Species (1986)	Chlorine (%, dry weight)	
			1985	1986
1	670 N	Silver	0.20	0.33
2	670 NNE	Manitoba	0.44	0.34
4	420 NE	Manitoba	0.93	0.96
6	600 NE	Sugar	0.40	0.34
8	690 NE	Red	0.32	0.26
9	810 NE	Silver	0.73	0.68
10	1060 NE	Silver	0.40	0.28
11	1370 NE	Manitoba	0.28	0.42
12	960 NNW	Silver	0.16	0.21
14	210 NW	Norway	0.55	0.94
16	710 E	Manitoba	0.13	0.18
19	580 WSW	Manitoba	0.19	0.34
21	540 SE	Silver	0.38	0.80
22	1810 ENE	Silver	0.47	0.60
23	1100 N	Silver	0.12	0.23
25	1730 NNE	Manitoba	0.33	0.21
27	920 ENE	Silver	0.32	0.45
32	2000 NE	Silver	0.32	0.54
33	790 NW	Norway	0.60	0.64
35	1620 WSW	Silver	0.67	0.32
36	2580 NE	Manitoba	0.22	0.20
37	3700 NE	Norway	0.28	0.36
Mean concentration in Cornwall samples			0.38	0.44
Controls (Ingleside)		Manitoba	0.08	0.11
		Silver	0.06	0.06
		Norway	0.20	0.34

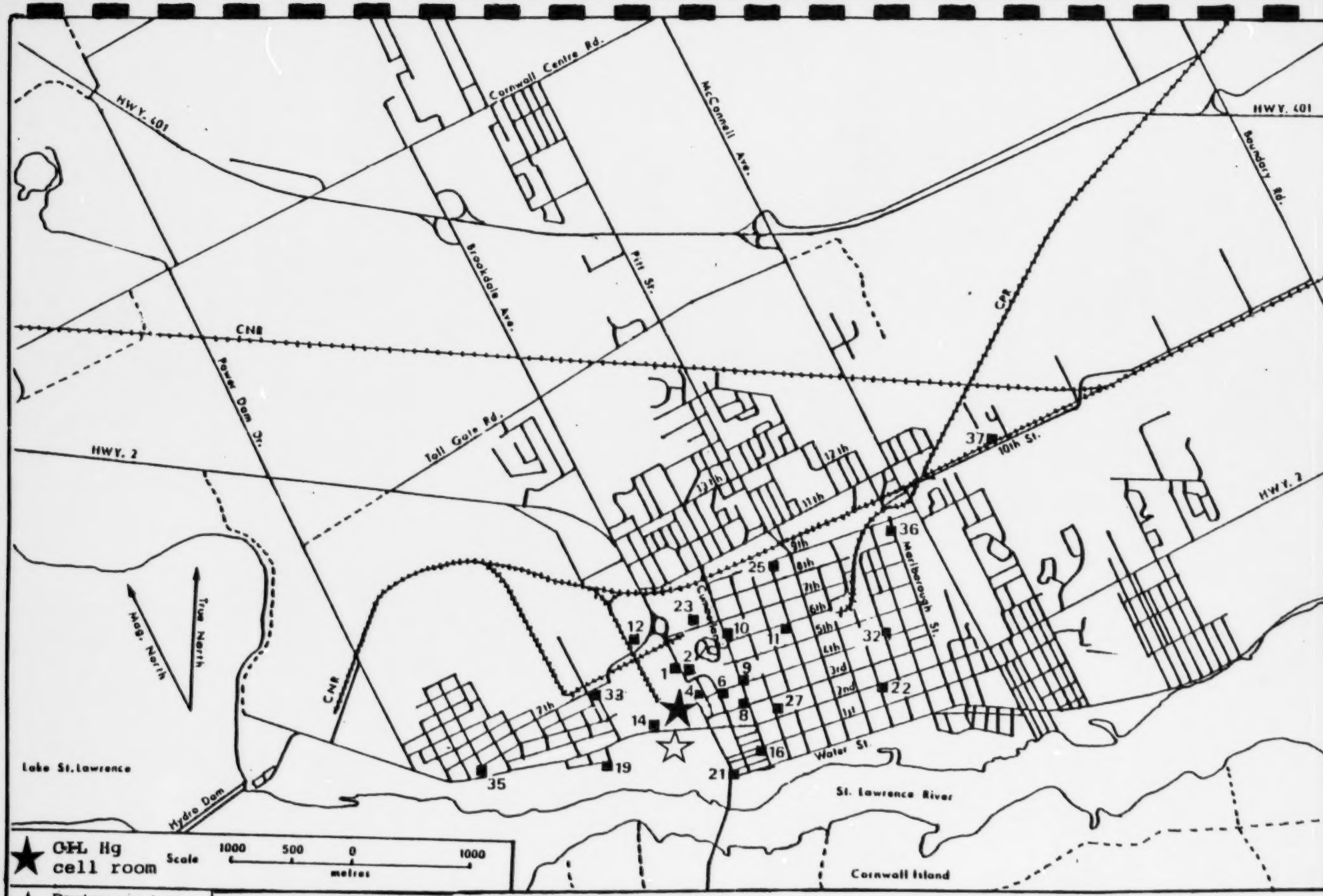


Figure 1 - Locations of soil and foliage sampling stations in the vicinity of C-IL and Domtar, Cornwall.

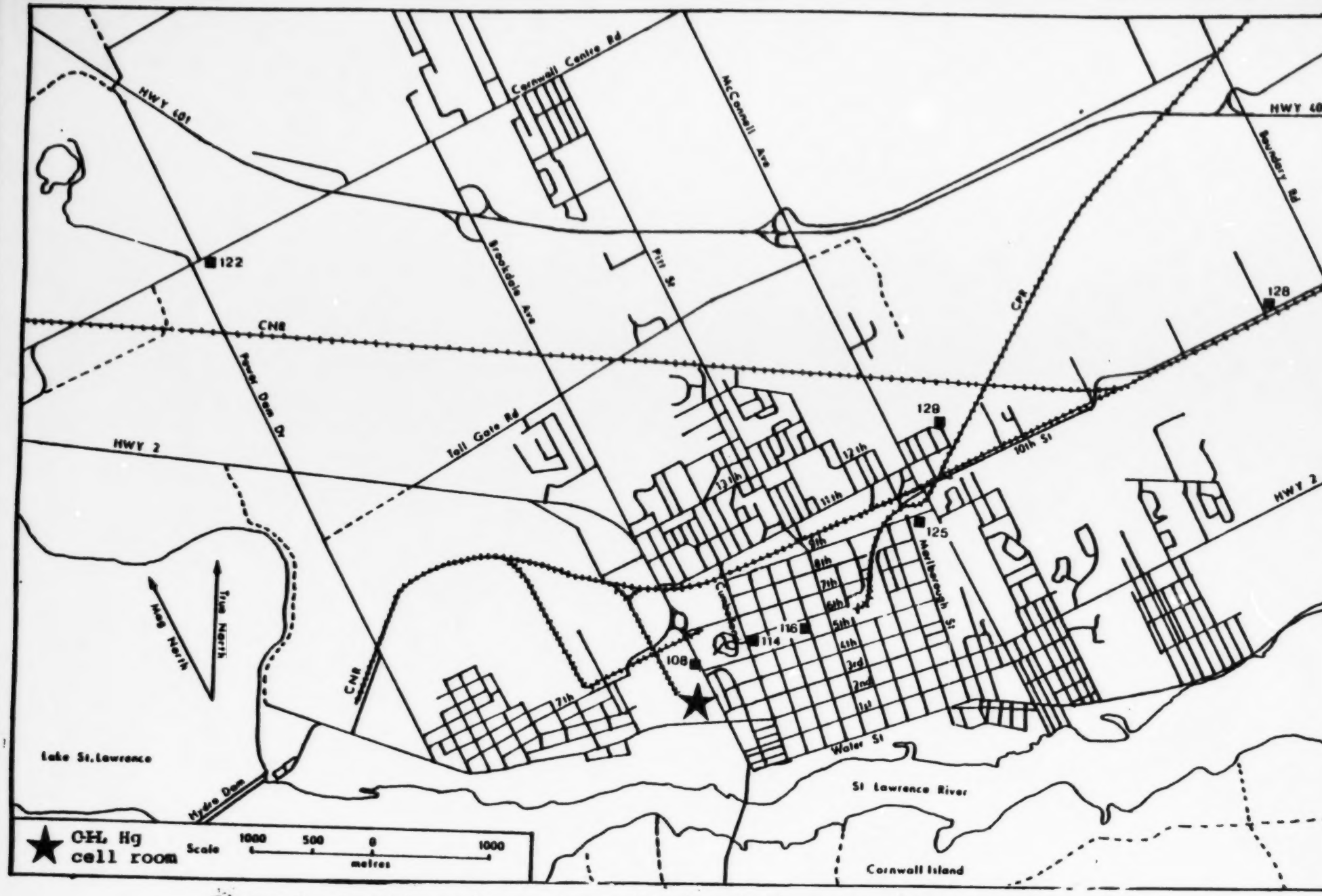
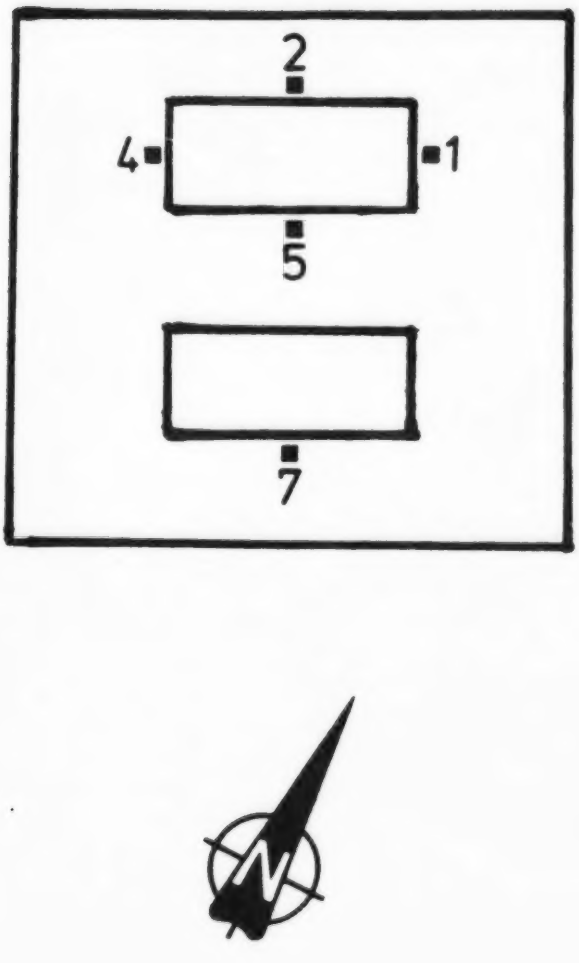


Figure 2 - Locations of moss bag monitoring stations downwind of CHL, Cornwall.

Figure 3 - Schematic diagram of roof of C-I-L Hg Cell Room, showing moss bag monitoring locations.



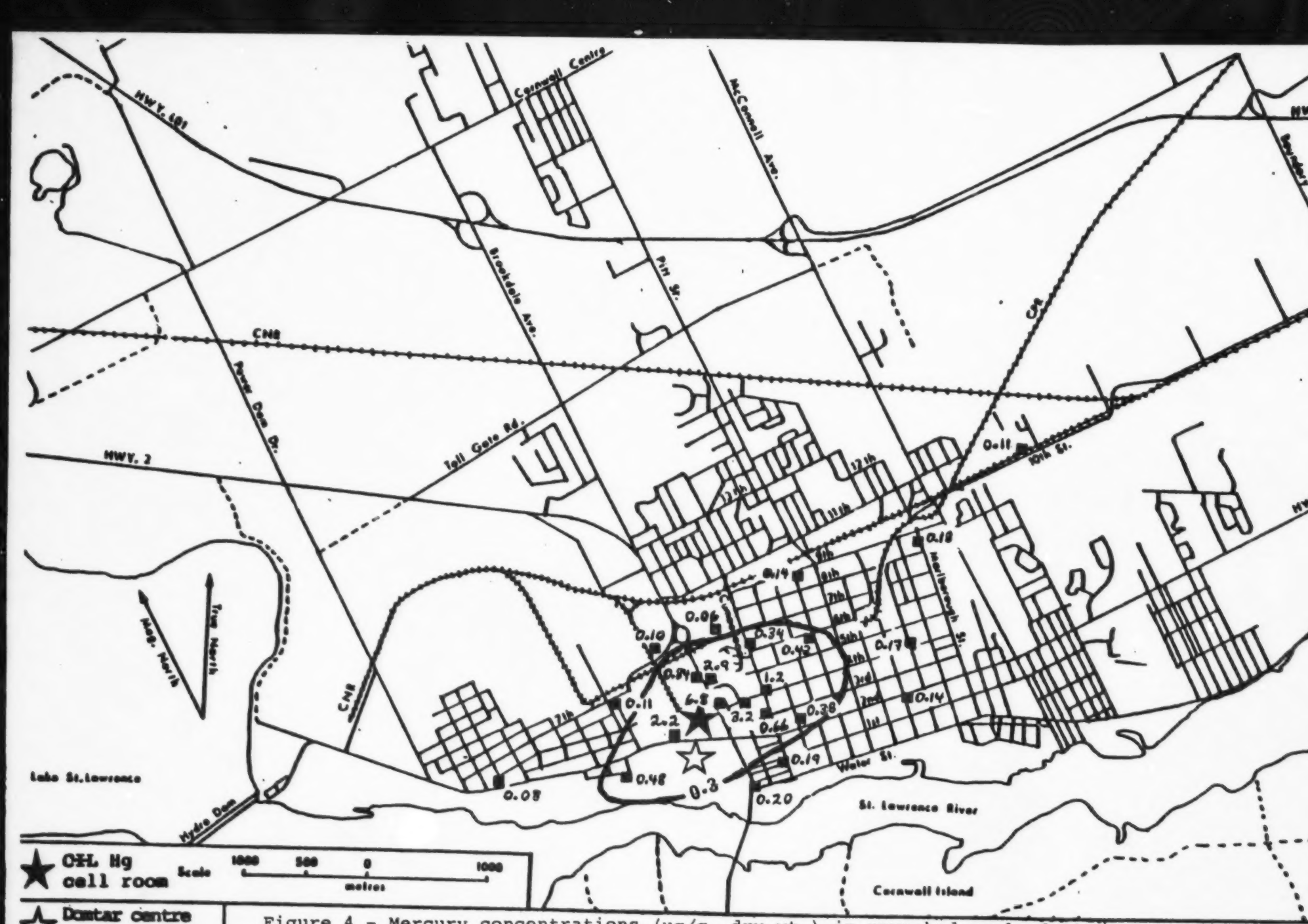


Figure 4 - Mercury concentrations (ug/g, dry wt.) in unwashed maple foliage in the vicinity of C-IL/Domtar, Cornwall - 1986.

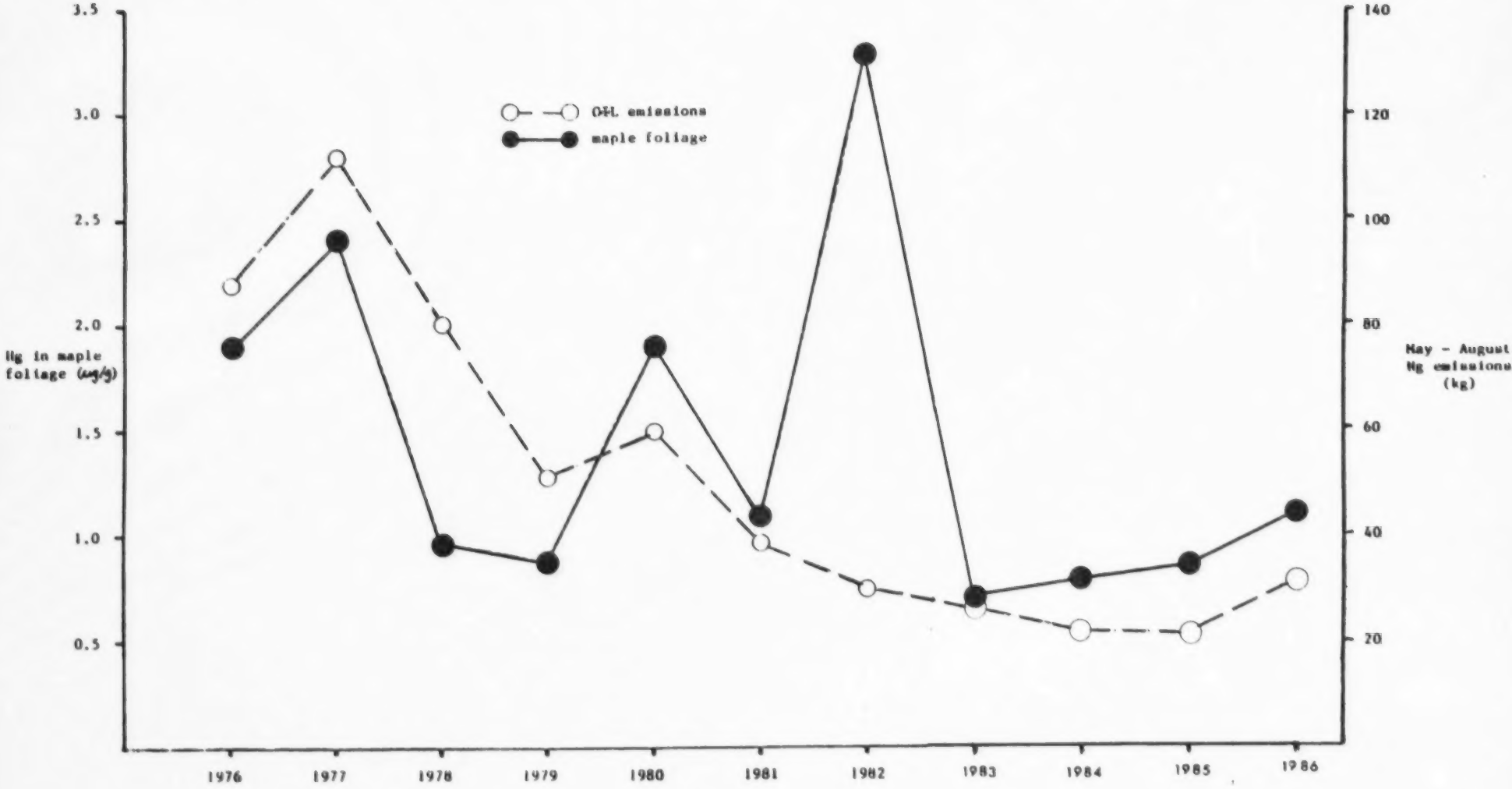


Figure 5 : OHL Hg emissions to atmosphere vs. Hg content of unwashed maple foliage (average of 18 stations) - 1976-1986.

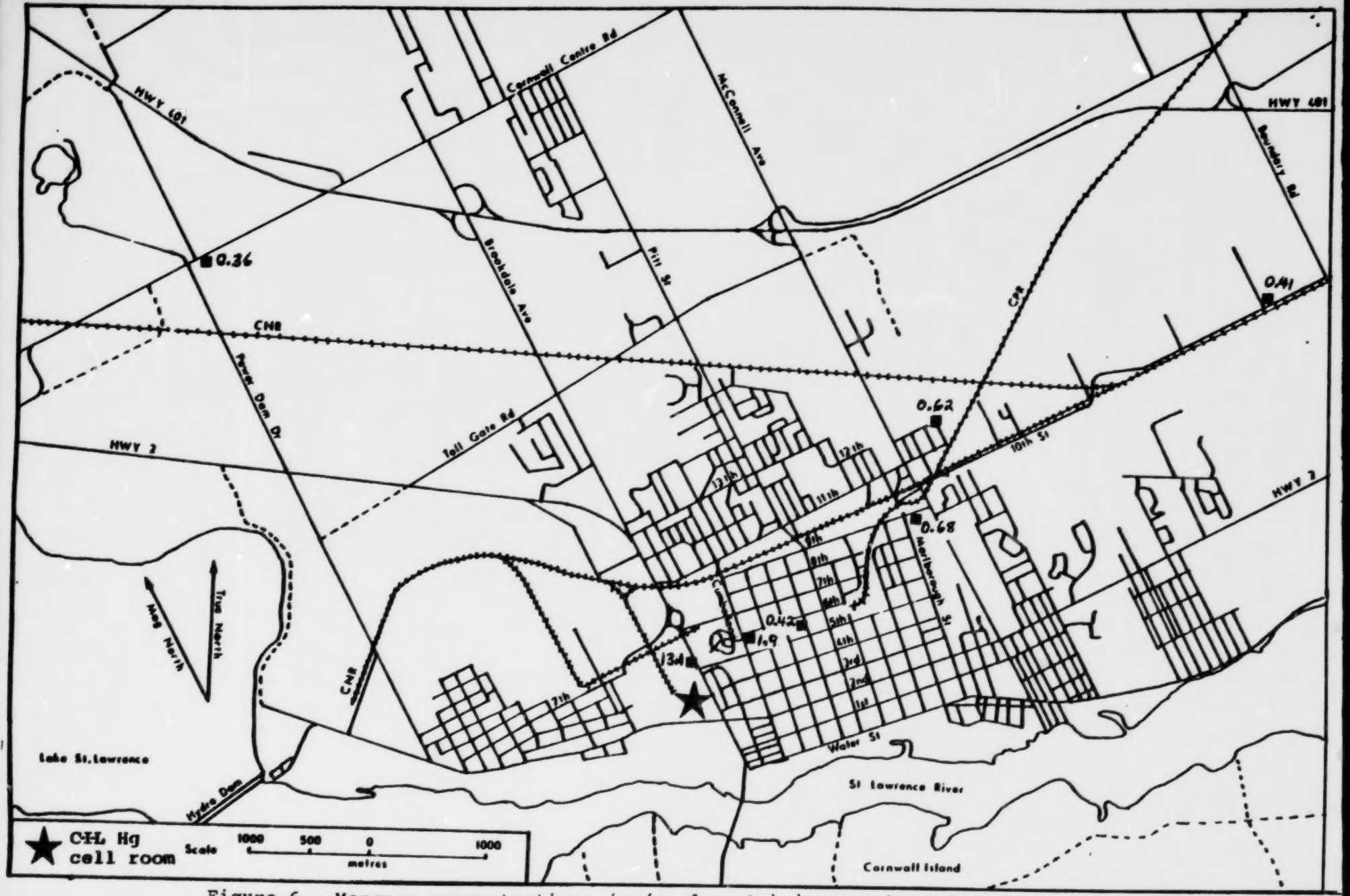


Figure 6 - Mercury concentrations (ug/g, dry wt.) in moss bags downwind of C-IL, Cornwall.
Results shown are averages of th[illegible] May [illegible]86 [illegible]os

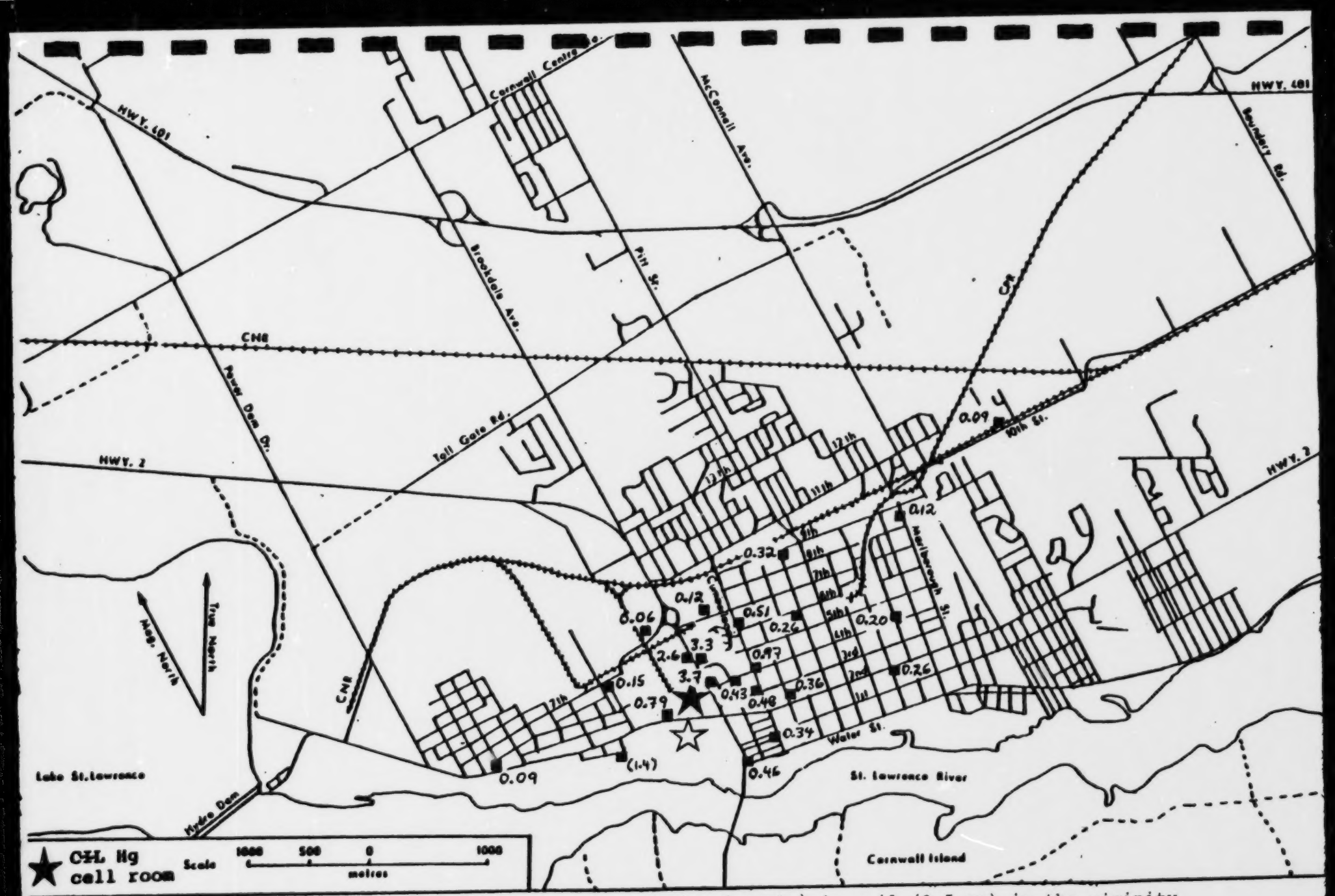


Figure 7 - Mercury concentrations (ug/g, dry wt.) in soil (0-5 cm) in the vicinity of C-IL/Domtar, Cornwall - 1985.

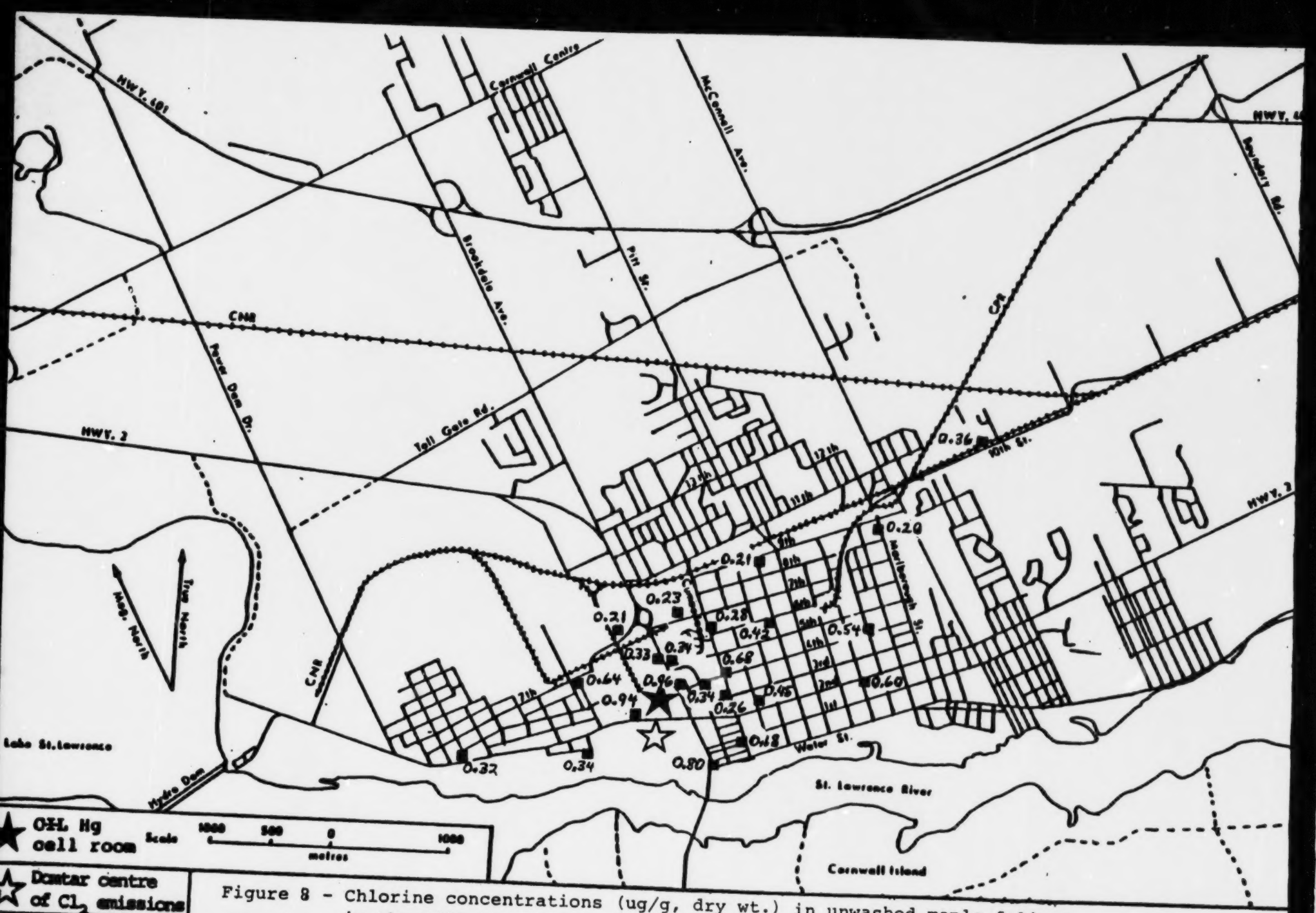


Figure 8 - Chlorine concentrations (ug/g, dry wt.) in unwashed maple foliage in the vicinity of OHL/Domtar, Cornwall - 1986.

Appendix 1

Temperature and Precipitation Statistics for 1984 at Cornwall (Ontario Hydro Station)

Month	Avg. max. daily temp. (°C)	Avg. mean* daily temp. (°C)	Precipitation (mm)		
			Rain	Snow	Total
January	-7.2	-10.7	4.2	27.4	31.6
February	0.5	-3.4	22.2	48.0	70.2
March	-1.7	-6.5	8.8	28.0	37.8
April	12.6	7.6	110.2	-	110.2
May	16.2	11.6	113.2	-	113.2
June	25.4	19.4	54.5	-	54.5
July	26.8	21.5	50.9	-	50.9
August	26.8	21.6	94.8	-	94.8
September	19.3	14.0	31.9	-	31.9
October	14.7	10.0	35.3	-	35.3
November	6.2	2.4	65.2	9.0	74.2
December	1.5	-3.0	43.1	63.5	106.6

*(Avg. max. + avg. min)/2

Appendix 2

Temperature and Precipitation Statistics for 1985 at Cornwall (Ontario Hydro Station)

Month	Avg. max. daily temp. (°C)	Avg. mean* daily temp. (°C)	Precipitation (mm)		
			Rain	Snow	Total
January	-8.0	-11.5	0	54.4	54.4
February	-3.1	-6.5	56.5	21.8	78.3
March	3.9	-0.5	52.3	35.0	87.3
April	11.6	6.6	67.0	2.8	69.8
May	19.3	13.9	69.7	0	69.7
June	20.8	16.3	145.2	0	145.2
July	26.0	20.9	92.7	0	92.7
August	24.8	19.9	76.6	0	76.6
September	22.0	16.8	123.3	0	123.3
October	14.1	10.0	75.4	0	75.4
November	4.7	1.9	54.3	11.2	65.5
December	-2.8	-6.2	7.5	71.1	78.6

*(Avg. max. + avg. min)/2

Appendix 3

Temperature and Precipitation Statistics for 1986 at Cornwall (Ontario Hydro Station)

Month	Avg. max. daily temp. (°C)	Avg. mean* daily temp. (°C)	Precipitation (mm)		
			Rain	Snow	Total
January	-4.2	-8.5	28.1	33.4	61.5
February	-5.3	-7.7	11.7	30.2	41.9
March	4.4	-0.6	39.3	37.6	76.9
April	15.6	9.4	43.1	-	43.1
May	19.9	14.5	90.3	-	90.3
June	22.5	17.0	107.5	-	107.5
July	25.5	20.5	165.2	-	165.2
August	23.9	19.0	103.5	-	103.5
September	19.1	14.6	139.7	-	139.7
October	12.6	8.7	84.2	-	84.2
November	4.4	0.8	56.0	9.8	65.8
December	0.0	-3.6	64.2	16.2	80.4

*(Avg. max. + avg. min)/2